

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Att. Docket: LUBOMIRSKY=1

In re Application of:	)	Conf. No.: 2902
	)	
Igor Lubomirsky	)	Art Unit: 1796
	)	
Appln. No.: 10/560,107	)	Examiner: Khanh Tuan Nguyen
	)	
I.A. Filed: June 10, 2004	)	April 26, 2011
§371(c) Date: December 9, 2005)	)	

DECLARATION UNDER 37 CFR §1.132

Sir:

The undersigned declarant, Igor Lubomirsky, declares and states the following.

He is the inventor named in the above-identified application and his professional qualifications and experience are set forth in the attached Curriculum Vitae.

He has studied U.S. Pat. No. 5,342,648 (hereinafter "MacKenzie"), and U.S. Application No. 10/560,107 (hereinafter "the application") and provides the following assertions and explanations based on that study.

The compounds claimed in the application are physically different from the compounds disclosed in MacKenzie

In the explanation of the rejection presented in the office action of January 31, 2011, the examiner asserts that the compounds claimed in the application are the same as those disclosed in the U.S. Patent to MacKenzie. It will be shown below that this is incorrect.

Declarant asserts that this is incorrect and ignores the fact that MacKenzie only discloses amorphous **ferroelectric** material, while the application claims only amorphous **pyroelectric** material. The Examiner considers that if the material compositions disclosed by MacKenzie and disclosed and claimed in the application are the same, then the ferroelectric and pyroelectric properties are similar. It is generally known in the art that since all ferroelectric materials exhibit a spontaneous polarization, all ferroelectric materials are also pyroelectric, **but not all pyroelectric materials are ferroelectric**. The basic difference between pyroelectric materials and ferroelectric materials is that in ferroelectric materials, the direction of the polarization is reversed as the applied electric field is reversed, while pyroelectric materials do not possess polarization reversal.

Fig. 1 of MacKenzie illustrates a hysteresis loop that is precisely an inherent characteristic of a ferroelectric material. As clearly shown in Fig. 1 of MacKenzie, in the hysteresis loop, the direction of the polarization is reversed as the applied electric field is reversed. Pyroelectric materials do not possess polarization reversal. MacKenzie neither discloses nor teaches any pyroelectric materials.

A given material composition may be in its ferroelectric or pyroelectric state. Ferroelectric material by definition is such pyroelectric in which electric polarization is reversibly changeable in response to the applied electric field. This is indeed utilized in MacKenzie. However, by definition, not every pyroelectric material is ferroelectric. The invention disclosed in the application utilizes pyroelectric material which has no polarization reversibility property. This is

specifically described in the application, for example, in the following passage that appears at page 13, lines 19-24 of the application:

The pyroelectric effect was confirmed independently by the continuous temperature ramping technique. The direction of the pyroelectric current indicates that the pyroelectric vector is directed toward the substrate. Application of an external electric field of  $\pm 200$  kV/cm does not alter the value or the sign of the pyroelectric current, demonstrating that the direction of the pyroelectric vector cannot be changed or reversed (absence of switching). (Emphasis added)

The above paragraph demonstrates the irreversibility of the orientation of the motifs and therefore of the polarization of the pyroelectric compound and therefore demonstrates the non-ferroelectricity properties of the compound of the present invention. According to the general knowledge in the field of pyroelectricity/ferroelectricity, the pyroelectric vector is directly connected to polarization: a change of spontaneous polarization results in appearance of a pyroelectric vector.

MacKenzie does not disclose pyroelectric compounds

In the explanation of the rejection, at page 4 of the office action, the examiner asserts that

MacKenzie discloses amorphous ferroelectric material subjected to mechanical strain such as poling and electric field ... which provides a quasi-amorphous compound with pyroelectricity as described by the applicant...

The declarant believes that the MacKenzie poling technique would not produce the compound of the present invention because the poling technique is not applied to the amorphous **non-ferroelectric** material to prevent crystallization and to induce pyroelectric/ferroelectric properties. Rather, the amorphous **ferroelectric** material (metal oxide-based ferroelectrics) is used as a precursor and is cooled in a D.C. electric field to verify that the sample has ferroelectricity properties, and not to create those properties.

MacKenzie states, at column 2, lines 28-34:

*It has now been discovered that stable ferroelectricity can be produced in amorphous materials formed by a modified sol-gel technique. The ferroelectric effect has not only been found in mixed metal oxides known to be ferroelectric in their crystalline state, but also in certain single metal oxides never previously known to be ferroelectric. The materials are stabilized, for example, by heating, so that stable ferroelectric properties persist during use of the films.*

From this it is clear that the product of MacKenzie can be obtained only by using the modified sol-gel technique disclosed therein. This sol-gel technique is the essence of MacKenzie's invention. The invention claimed in the application does not use a sol-gel technique. Therefore, the resulting product cannot be similar to the MacKenzie product.

The specification of the application discloses that compounds according to the invention do not have ferroelectric properties. The fact that the polarization direction of compounds according to the present invention is permanent and cannot be changed by the application of an external electric

field supports the fact that these compounds do not have ferroelectric properties.

Declarant performed tests on a sol-gel derived  $\text{BaTiO}_3\text{As}$  compound disclosed in Mackenzie to attempt to create a pyroelectric current therein but could not produce any pyroelectric effect. Moreover, attached hereto are two scientific articles coauthored by the inventors named in the Mackenzie patent, in which the material of the Mackenzie patent is called "ferroelectric-like". The compounds described in there articles are not described as having any pyroelectric effect.

Mackenzie does not disclose compounds prepared by a method corresponding to that of the invention claimed in the application

The compositions claimed in the application are different as a result of being prepared by a different method. Specifically:

Preparation of the compounds claimed in the application start from an amorphous film, while MacKenzie starts from a powder of ferroelectric amorphous material;

According to the invention claimed in the application, a mechanical strain is applied to the film, which step is absent from Mackenzie, and applies this strain in a predetermined manner, for example as defined in claim 42 of the application, controlled so as to prevent crystallization of an inorganic compound. The pyroelectric properties of the quasi-amorphous compound are created by stress induced dipole ordering. The

mechanical strain in MacKenzie (poling and electric field) is not applied to the amorphous ferroelectric material to prevent crystallization and to induce pyroelectric/ferroelectric properties, but rather the amorphous ferroelectric material is used as a precursor and is cooled in a DC electric field to verify that the sample has ferroelectricity properties and not to create them; and

The invention claimed in the application creates pyroelectric amorphous material having no polarization reversibility, while MacKenzie creates a ferroelectric amorphous film.

It is clear that MacKenzie is solely aimed at forming a ferroelectric amorphous film from a powder of such material, while preventing crystallization during the film formation.

As already noted above, MacKenzie uses a sol-gel technique, which cannot create a condition that the amorphous material tends to expand prior to crystallization, while the invention utilizes amorphous film deposition on a substrate by sputtering, which does create such condition, followed by application of a mechanical strain with a gradient having two components: in-plane (along the temperature gradient), and out-of-plane (a result of the clamping caused by the cold part of the film).

Page 8, lines 13-18, and page 10, lines 1-5, of the specification of the application state:

*The method of the present invention comprises subjecting **sputtered amorphous compound films** to a **mechanical strain**. This can be implemented by passing the film through a steep temperature gradient. The temperature gradient has to be carefully controlled and to be such as to prevent*

crystallization of the amorphous compound, thereby obtaining highly stressed amorphous films. In a thin film clamped by a substrate, volume expansion is restricted and nucleation may be completely suppressed. This indeed occurs if an as-deposited amorphous film is pulled through a temperature gradient. The obtained quasi-amorphous phase retains thermal stability as long as the mechanical constraints are in place.

Therefore, the technique of the invention claimed in the application is based on sputtering, while the MacKenzie technique is based on sol-gel. Sputtering of the film clamped by a substrate makes available a unique feature in which a volume expansion of the deposited material is restricted and nucleation may be completely suppressed. An internal mechanical strength is created in some regions of the film, inducing the high in-plane compressive stress. The high in-plane compressive stress can be obtained only by using the sputtering technique of the present invention.

Moreover, in the present invention, a mechanical strain gradient should be applied to obtain stress-induced polarization, as described in the following passage at page 9, lines 12-20 of the specification of the application:

The steep temperature gradient during formation of the quasi-amorphous films generates a gradient of mechanical strain<sup>[16]</sup> that poles the films due to the flexoelectric effect<sup>[17]</sup>. The strain gradient has two components: in-plane (along the temperature gradient), and out-of-plane (a result of the clamping caused by the cold part of the film)<sup>[16]</sup>. The latter component is responsible for the out-of-plane orientation of the crystal motifs in the films. Thus, if the crystal motifs are polar, their partial orientation creates a sense of polarity in a quasi-amorphous film as a whole. Once formed, the

motifs cannot change their orientation due to the large in-plane compressive stress<sup>[18,19]</sup>.

It is understood by those skilled in the art that if the orientation of the crystal motifs cannot change, then the direction of polarization cannot change.

The strain should be applied in a specific manner: The as-deposited amorphous film is pulled through a temperature gradient clamping a thin film to a substrate to restrict volume expansion and suppressing nucleation; passing the film through a steep unidirectional temperature gradient generating a gradient of mechanical strain, the strain gradient having one in-plane component along the temperature gradient and one out-of-plane component. The out-of-plane component induces a stable orientation of the molecular grouping due to compressive stress from the in-plane component. The temperature gradient is controlled so as to prevent crystallization of the amorphous compound, thereby obtaining highly stressed amorphous films.

#### CONCLUSION

In view of the above, it is clear that the technique of the invention claimed in the application and the resulting product are different from those of MacKenzie. The resulting products are different: MacKenzie suggests a quasi-amorphous compound having ferroelectric properties (polarization change in response to application of external field), while the application claims are limited to quasi-amorphous oxide



compounds having piezoelectric properties excluding ferroelectric properties (the direction of the pyroelectric vector cannot be changed or reversed).

Declarant hereby further declares that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. §1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date 4/26/2011

  
Signature

Igor Lubomirsky  
Name